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## SEMI-ANNUAL STATUS REPORT

Reporting Period December 1, 1974 - May 31, 1975

Grant No. NGL 15-005-186

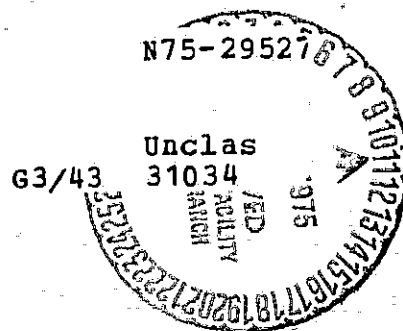
Title of Investigation:

The Application of Remote Sensing Technology  
to the Solution of Problems in the Management  
of Resources in Indiana

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(NASA-CR-143317) THE APPLICATION OF REMOTE  
SENSING TECHNOLOGY TO THE SOLUTION OF  
PROBLEMS IN THE MANAGEMENT OF RESOURCES IN  
INDIANA Semiannual Status Report, 1 Dec.  
1974 - 31 May 1975 (Purdue Univ.) 14 p HC



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## I. Introduction

This semi-annual status report covers the period from December 1, 1974 to May 31, 1975 and contains a review of the research and applications, completed or in progress, as funded by the Office of University Affairs, NASA and conducted by Purdue University, Laboratory for Applications of Remote Sensing.

This reporting period marks the completion of the second year of funding for a proposal entitled "The Application of Remote Sensing Technology to the Solution of Problems in the Management of Resources in Indiana." As indicated in this title, the purpose of this work is to introduce remote sensing into the user community within the state of Indiana. The user community includes those local, regional and state agencies involved in the decision monitoring and/or managing processes of the state's resources.

In order to carry out this work it is not only necessary to initiate projects with these agencies but also it is necessary to meet with and provide information to as many people and groups as well as agencies as possible. During the past six months eleven meetings were held with seven different groups. Approximately 53 people heard and participated in these meetings.

Among the groups that were contacted and received information about this program were:

- ° U. S. Forest Service, Hoosier National Forest
- ° Indiana Department of Natural Resources,  
Division of Reclamation
- ° U. S. Department of Agriculture/  
Soil Conservation Service
- ° Indiana State Highway Commission,  
Division of Planning
- ° Indiana State Planning Agency
- ° U. S. Department of Agriculture/  
Agriculture Research Service
- ° Indiana Geological Survey
- ° Indiana Heartland Coordination Commission.

Listed below are the projects that are in progress or completed and reported in this document.

### Land Use Inventories

1. Strip Mining and Reclamation in Southwestern Indiana
2. Highway Relocation, Ft. Wayne, Indiana

## Water Resources

### 1. Power Plant Siting Project

## Technique Development

1. Data Base Development
2. Location of Dolomite Reefs in Northwestern Indiana

This report is organized in such a manner that each of the projects is reported separately. The background, status and conclusions are given for each project.

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## II. Project Reports

### A. Land Use Inventories

#### 1. Strip Mining and Reclamation in Southwestern Indiana

##### Background

During the first half of FY75 LARS supplied the Indiana Department of Natural Resources, Division of Reclamation with a land use classification covering a portion of the coal producing area in southwestern Indiana. The accuracy of these results was to be field checked by personnel from the Division of Reclamation.

On January 22, 1975 a meeting between LARS and Division of Reclamation personnel was held to review the results of the field checking operation. In the majority of cases, the classes associated with strip mining and reclamation activities were accurately identified. However, in evaluating these classification results, personnel from the Division of Reclamation became aware of the limitations of LANDSAT's resolution. Small strip mines and strip pits could not be routinely identified as such.

After reviewing the previous classification results, Division of Reclamation personnel expressed a desire to obtain a more detailed land use inventory, especially with regards to land use categories other than those associated with strip mining but located in the same area. In response to this request LARS agreed to prepare a detailed land use inventory of one county.

Sullivan County was selected for the detailed inventory since one of the former test sites for this project had been located within the county. A single date analysis was conducted on LANDSAT data collected on June 9, 1973. Limited coverage of RB-57 color infrared photography was utilized as underflight reference data. Land use categories identified included:

1. Row crops
2. Close grown crops and pasture
3. Strip mines
4. Water
5. Deciduous forest
6. Coniferous forest

Tabular acreage estimates, slides and hard copy output of the classification results were supplied to the Division of Reclamation in April 1975. At this time cost estimates were discussed relating to the preparation of a land use inventory of the coal producing areas within Indiana.

### Project Status

Division of Reclamation personnel are reviewing the latest classification results and assessing their utility in establishing criteria for restoring mined areas to conditions similar to surrounding areas.

LARS is awaiting further response from the Division of Reclamation, concerning the production of a complete inventory (at state expense) of strip mine areas in Indiana. LARS personnel may be asked to present the results of this project to the Conservation Advisory Committee of the Legislature in order to help obtain the needed funding.

### Conclusions

LARS has demonstrated the capability of using remote sensing technology to inventory and monitor land use in an area where active strip mining is occurring. Further work in this area is contingent upon funding by the Division of Reclamation.

## 2. Highway Relocation, Ft. Wayne, Indiana

### Background

The Indiana State Highway Commission is presently planning a by-pass route around Ft. Wayne, Indiana. Standard procedures for site location generally utilize ground observations, soil borings, and low level aerial photography. The objective of this effort is to determine the utility of satellite data, with its synoptic view, as a tool in highway siting, in particular route selection for the Ft. Wayne dual lane by-pass. The specific problems encountered in this project are determining the soil conditions along the route and the optimum river crossings for the proposed highway.

Satellite data utilized in this study consist of 1) Skylab IV MSS data collected January 25, 1974 and 2) LANDSAT MSS data collected June 8, 1973. In addition, the following reference data are being used:

- 1) Aerial photography flown April 29, 1975
- 2) Agricultural soils map of Allen County
- 3) Engineering soils map of Allen County
- 4) USGS 7½ minute topographic quadrangle of northeastern Ft. Wayne.

### Project Status

To date the Skylab MSS data have been analyzed and work is progressing on analysis of the LANDSAT MSS data.

Prior to analysis, the test site was subdivided into three areas based upon the predominant landforms, i.e., (lacustrine deposits, glacial till and a transitional zone). A supervised classification of the Skylab data for each of the three areas was performed using statistics generated from a clustering algorithm. The classification results obtained were of dubious value due to the presence of snow and extremely wet areas existing in the scene at the time of data collection.

Analysis of the LANDSAT data is continuing and results are expected by early September.

### Conclusions

Results of the Skylab data were not useful in discerning soil materials because of the presence of snow and very wet soils. Results of the LANDSAT data may yield information about soil types and soil associations which may be helpful in planning the route of the Ft. Wayne by-pass.



## B. Water Resources

### 1. Power Plant Siting Project

#### Background

As described in the previous six-month report, LARS has been developing a means to model the nature and distribution of thermal discharges into rivers. Remotely sensed surface temperature measurements can be input into a model to describe the 2-dimensional variation of surface temperature due to thermal pollution. However, surface thermal data currently cannot provide information in three dimensional space.

US/EPA regulations concerning thermal pollution from power plant discharges require information about the cross-sectional temperature variations. At the suggestion of the Chicago Office of the US/EPA, LARS has undertaken an investigation to determine how remotely sensed surface thermal data can be used as a boundary condition for input into a 3-dimensional temperature model.

#### Project Status

Research towards modeling the third dimension of the thermal plume is progressing rapidly. The model currently being developed uses the following input parameters:

1. Ambient river temperature
2. River flow rate
3. River slope
4. Heat discharged
5. Effluent discharged
6. Angle of discharge.

A test of the model is scheduled to be run prior to 1 September 1975. However, additional ground observations may need to be collected to allow for verification of the model.

Presently, a 2-dimensional analysis of thermal data collected south of Terre Haute, Indiana over the Wabash River is scheduled to be used in a US/EPA hearing in August concerning the construction of a new power plant by the American Electric Power Co. This information, developed under a contract with WAPORA, Inc., indicates the growing need for quantitative information about the nature and distribution of thermal pollution.

#### Conclusions

Upon completion, the 3-dimensional model will provide a cross-sectional profile of thermal plumes emitted by point sources of thermal pollution into rivers or lakes. This infor-

mation will enable the US/EPA to more objectively evaluate 316 current petitions to exceed EPA standards from public utility companies. If these petitions are rejected, the utility companies will need to construct and implement other types of cooling systems to reduce the thermal pollution of streams.

Thus, this model will assist the US/EPA in arriving at a more objective enforcement decision which can directly affect the quality of our environment. Utility companies likewise could make use of this model in the design process of future proposed power plants.

## C. Technique Development

### 1. Data Base Development

#### Background

During the first year of work under this proposal a data base development activity was begun in which a 10 x 14 kilometer area in Tippecanoe County, Indiana was represented. A digital data base containing approximately thirty land use and surface characteristic variables was encoded in a 100 meter square grid. The data base was used to produce land characteristics maps and suitability maps for various proposed land uses. The computer software and the techniques developed in this effort formed the foundation for the Data Base Project which seeks to apply this technology to the land use decision making process in Indiana.

Activity on the project in the first half of 1975 concentrated on expanding the capabilities of the data base to enable overlay of LANDSAT and other remote sensing data classification results onto the data base grid. Also, output capabilities were expanded to include the capability to produce black and white and color transparencies of data base output maps. These capabilities have been implemented and are ready for use in a data base application.

#### Project Status

The existing Tippecanoe County data base was utilized to produce a variety of color coded output maps to illustrate the capabilities of the data base system. A meeting was held with the Indiana State Planning Services Agency to explain applications of the data base capability and the color illustrations generated were presented to this group. The Indiana Heartland Coordinating Commission emerged as the most likely body to make good use of the data base capability for planning decisions. Work began to define a project which would fit with needs of the IHCC and have good potential for aiding in their decision making process.

Meetings were also held with a Land Use Planning Group in Delaware County, Indiana which has the requirement to generate a digital data base for planning in that area. The data base capabilities will be applied to an area in that county in summer 1975. Other applications of the capabilities are being sought and a potential third project in the Indiana Coastal Zone along the southern shore of Lake Michigan is being discussed with a State agency.

## Conclusions

The basic data base experiment has been developed to the point where it can be applied to land use analysis and decision making processes in the state. Potential applications are being pursued and data extraction and processing is expected to begin in summer 1975. The Indiana Heartland Coordination Commission and Delaware County planning group are expected to derive benefits from these techniques for decision making.

## 2. Dolomite Reef Study of Northwestern Indiana

### Background

Crushed stone for construction purposes is in short supply in northwestern Indiana because of a combination of thick cover of glacial deposits and the limited extent of usable bedrock materials in the subsurface. The problem is becoming particularly significant as this portion of Indiana experiences a high population growth with a continually increasing need for quality construction materials.

Dolomite pinnacle reefs occur in Silurian age rocks in a band which trends across northwestern Indiana. These reefs protrude through younger bedrock materials which were deposited around them during later sedimentation. Such reefs form because of localized prolific growth of corals, sponges and other carbonate producing animal life in a specific area of the inland ocean. Where the glacial cover is thin, such resistant rocks may be found today within 10's of feet below the earth's surface.

A few years ago information from water well logs and earth resistivity studies lead to the discovery of a dolomite pinnacle reef near Lowell, Indiana. Since much of the area adjacent to this reef is under agricultural use and water wells are not abundant in that area, location of additional pinnacle reefs has not been successful. However, remote sensing has been suggested as an aid to locating additional pinnacle reefs.

### Project Status

An area surrounding the dolomite quarry at Lowell, Indiana was selected as the test site. This area is located over Silurian age bedrock and generally is covered by 50 feet or less of glacial drift. Specific test areas were delineated within the test site. These areas contained those portions of the test site which were actually covered by 50 feet or less of glacial drift. Separate data sets were generated from LANDSAT MSS data for the specific test areas by using an irregular boundaries program to delineate their extent. Geologic maps were utilized as reference data in this operation. During the analysis the quarry at Lowell, Indiana and surrounding areas were used as the primary training sites and the specific test areas were classified from these statistics.

In addition to the LANDSAT data, RB-57 scanner data collected during the Corn Blight Watch were also available over the test site. These data were obtained from the Environmental Research Institute of Michigan (ERIM) and with much

difficulty converted into a digital format and reformatted for analysis with the LARSYS software system. This has only recently been accomplished and the aircraft scanner data have not been analyzed.

### Conclusions

The analysis results of the LANDSAT data were generally inconclusive. Many areas within the test site exhibited a spectral response similar to the training site.

The LANDSAT classification will be compared to the one based on aircraft scanner when the latter is accomplished. It is hoped that fewer anomalies will emerge from classification of the aircraft data. Promising areas may be field checked with subsequent geophysics and drilling programs.

### III. Summary

To date, this entire program has been aimed at the dissemination of remote sensing technology to user agencies within the state of Indiana. The thrust of our effort has been to acquaint these organizations with remote sensing through talks, demonstrations and actual problem solving projects that are directly associated with these agencies. The projects reported here are the sum of LARS efforts to accomplish this goal using the funds available from the Office of University Affairs.

A review of the current projects is scheduled to be held in early September 1975. At that time, those projects which are meeting the goals of the overall project will be continued and possibly expanded. Projects which show little promise will be redirected or terminated.